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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In Cooperation with the Wisconsin Geological and Natural History Survey
and the University of Wisconsin College of Agriculture

SOIL SURVEY
OF
PIERCE COUNTY, WISCONSIN

BY
W. J. GEIB, in Charge, M. J. EDWARDS, and E. H. TEMPLIN
U. S. Department of Agriculture
and
H. R. LATHROP
Wisconsin Geological and Natural History Survey

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SOIL SURVEY OF PIERCE COUNTY, WIS.

By W. J. GEIB, in Charge, M. J. EDWARDS, and E. H. TEMPLIN, U. S. Department of Agriculture, and H. R. LATHROP, Wisconsin Geological and Natural History Survey

COUNTY SURVEYED

Pierce County is in the west-central part of Wisconsin and is separated from Minnesota by Mississippi River and St. Croix River. The county is bounded on the south by Mississippi River, and that river and St. Croix River form most of the western boundary. The county has an extreme length, east and west, of about 33 miles and a width north and south of about 22 miles. Its area is about 586 square miles, or approximately 375,040 acres.

FIGURE 46.—Sketch map showing location of Pierce County, Wis.

Viewing this region from an elevated position, the impression received is that the surface is a gently rolling plain. Closer inspection shows that it has been dissected and that deep, steep-sided valleys, between which are high, smooth-topped, gently rolling ridges, have been formed. The details of the relief of the northeastern part of the county have been modified by glacial deposition. Westward, the evidences of glaciation become less evident, stream dissection is more prominent, the valleys become deeper and broader, and the interstream ridges become narrower. Along Mississippi and St. Croix Rivers and their numerous tributary streams, the valleys are bounded by steep bluffs ranging from 200 to 500 feet above the water level of the streams.

Martin's Physical Geography of Wisconsin indicates that the general elevation of the upland part of Pierce County is about 1,100 feet above sea level, but the elevation of the highest point is somewhat greater. It is probable that maximum differences in elevation between the highest and lowest points in the county approximate 500 feet. The following table shows the elevation in various parts of the county, and the authority for these elevations.

Elevations at different places in Pierce County

Place	Elevation	Authority	Place	Elevation	Authority
	Feet			*Feet*	
Ellsworth	1,069	C. & N. W. Ry.	Hager City	719	Mississippi River Commission
Beldenville	976	Do.			Do.
River Falls	887	Do.	Bay City	689	
Maiden Rock	682	Mississippi River Commission	Spring Valley	941	C. & N. W. Ry.
			Elmwood	780	Do.
Prescott	702	C., B. & Q. Ry.			

Pierce County lies entirely within the drainage basin of Mississippi River, and most of the drainage water finds its way directly into this stream. Lake Pepin, an enlargement of Mississippi River, bounds the county for a number of miles on the south. In the northern end of the lake Mississippi River has built a delta which is still growing. The lower course of St. Croix River, on the boundary of the county, forms a long, narrow body of water (Lake St. Croix), where the channel is obstructed by Mississippi River deposits. St. Croix River is navigable by steamboats from Prescott to Stillwater, St. Croix County. The numerous tributaries of Mississippi and St. Croix Rivers reach into all parts of the county and drain it thoroughly.

The western part of Wisconsin and what is now Pierce County was visited by French priests, traders, and explorers as early as 1680. No permanent settlements were established at that time. In 1830 a new era was opened for the Mississippi Valley by the Louisiana Purchase. In 1849 Philander Prescott entered several tracts of land at what is now Prescott. About this time the township of Elizabeth was formed as a part of St. Croix County. This included all of what is now Pierce County. Pierce County was set off from St. Croix County in 1853. Because it was adjacent to Mississippi River and because most of the prairie land and thinly forested areas lay in that section the western part of the county was settled first. Hunting, trapping, and later lumbering attracted the settlers. The early reports concerning the agriculture of this region were very glowing. It is reported that wheat averaged 50 bushels to the acre, and that yields of other crops were proportionately high. From 1850 to the time of the Civil War settlement was rapid. The first school was started in 1851. A settlement was made in Rush River Valley as early as 1840, and in 1844 and 1845 a colony came from Ohio and settled in Oak Grove Township.

Logging operations were very important, especially in country tributary to streams down which timber could be floated. In 1855 a ogging company cut more than 1,000,000 feet of pine logs in the township of Martell. Pine timber was cut first, and much hardwood was cut and burned in the process of clearing the land.

After the Civil War and the coming of the railroads settlement was again rapid, and agricultural lands came rapidly under cultivation. Iron was discovered in the northeastern part of the county, and a large furnace and foundry were erected at Spring Valley. This industry reached a high stage of development, but finally declined on account of economic conditions, and for 15 or more years there has been no activity whatever along this line.

Ellsworth is the county seat of Pierce County, but River Falls, part of which is in St. Croix County, is the largest town. In 1860 the county had a population of 4,672, according to the United States census, and in 1865, according to the State census, the population was 6,324. In 1920 the total population for the county was 21,663, all of which is classed as rural. Of the entire population 86.3 per cent are native-born whites. Residents of foreign birth came chiefly from Norway, Sweden, and Germany. At the present time all parts of the county are well settled and highly developed.

Two railway systems traverse the county. A branch of the Chicago & North Western Railway crosses the northeastern part of the county, running through Spring Valley and Elmwood, and joins the main line at Woodville. Another branch leaves the main line at Hudson and terminates at Ellsworth, the county seat. The main line of the Chicago, Burlington & Quincy Railroad crosses the county and follows closely along Mississippi River. Ellsworth is 273 miles from Madison, 357 miles from Milwaukee, and 43.9 miles from St. Paul, Minn.

The main dirt roads throughout the county are mostly graded and are usually in good condition. Silty soils predominate and make fairly good road material. Many miles of State and county trunk highways within the county are graded and surfaced with gravel or crushed rock. The number of miles of such roads is gradually increasing.

Mississippi River and Lake St. Croix form an excellent avenue for water transportation. Pleasure boats frequently run excursions up and down the river and on the lake for short distances, but regular freight and passenger traffic is almost at a standstill.

The towns within the county afford markets and shipping points for the farm products. Some of the whole-milk and manufactured dairy products go to Minneapolis and St. Paul, and some are shipped to Chicago and other markets. Most of the livestock is marketed at St. Paul. The dairy industry affords a home market for considerable quantities of hay, most of which is home grown. Fish from Lake Pepin and Lake St. Croix are shipped as far east as New York. Considerable farm produce is marketed through county cooperative organizations.

CLIMATE

The climate of Pierce County is characterized by warmer summers and much cooler and drier winters than the Lake Michigan shore.

The records of the United States Weather Bureau station at River Falls are representative of climatic conditions in the northern part of the county, and those of the station at Red Wing, Goodhue County, Minn., are fairly representative of the southern part.

The rainfall is well distributed throughout the year and is sufficient for the growing of all crops suited to this county. In some years some crops suffer from lack of moisture during the latter part of the summer. Such droughts are seldom severe or of long duration, and total crop failure from drought is very rare.

The frost-free season at Red Wing, Goodhue County, averages 155 days and at River Falls 121 days. The latest recorded killing frost at Red Wing and River Falls, respectively, was on May 22 and May 25, and the earliest was on September 26 and September 13. The frost-free season is long enough to mature most crops grown in the county.

The following tables give the more important climatic data as recorded at the Weather Bureau stations at Red Wing, Goodhue County, and at River Falls:

Normal monthly, seasonal, and annual temperature and precipitation at Red Wing, Goodhue County, Minn.

[Elevation, 680 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1911)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	17.6	54	−25	1.14	0.57	2.84	8.2
January	11.4	52	−41	1.18	.93	1.30	12.3
February	14.8	54	−36	1.10	.14	1.16	8.7
Winter	14.6	54	−41	3.42	1.64	5.30	29.2
March	29.2	65	−17	1.37	.04	1.15	7.6
April	45.8	89	14	2.32	.86	2.10	2.1
May	56.6	92	25	3.59	2.42	3.28	.3
Spring	43.9	92	−17	7.28	3.32	6.53	10.0
June	68.5	100	38	4.50	.44	5.34	.0
July	72.6	106	46	3.32	1.90	4.52	.0
August	69.6	97	38	3.43	2.52	4.63	.0
Summer	70.2	106	38	11.25	4.86	14.49	.0
September	62.5	95	28	3.64	1.94	4.14	Trace.
October	51.1	84	7	2.70	.72	9.60	.5
November	35.2	78	−21	1.41	.80	1.34	3.8
Fall	49.6	95	−21	7.75	3.46	15.08	4.3
Year	44.6	106	−41	29.70	13.28	41.40	43.5

Normal monthly, seasonal, and annual temperature and precipitation at River Falls

[Elevation, 906 feet]

Month	Temperature	Precipitation		
	Mean	Mean	Total amount for the driest year (1925)	Total amount for the wettest year (1922)
	°F.	Inches	Inches	Inches
December	17.0	0.86	0.87	0.16
January	12.0	.88	.51	.80
February	15.2	1.03	.56	3.07
Winter	14.7	2.77	1.94	4.03
March	27.6	1.80	.57	2.08
April	43.2	2.03	1.32	2.91
May	51.0	4.03	2.37	6.06
Spring	40.6	7.86	4.26	11.05
June	66.3	6.20	9.17	5.52
July	69.7	3.73	4.09	2.11
August	68.3	3.13	.06	2.20
Summer	68.1	13.06	13.32	9.83
September	60.3	3.74	4.71	2.80
October	47.4	1.68	1.15	1.22
November	31.2	1.71	.65	4.14
Fall	46.3	7.13	6.51	8.16
Year	42.4	30.82	26.03	33.07

AGRICULTURE

Pierce County is a region of diversified farming. During the past 20 or 30 years a gradual change has taken place from a system in which grain farming predominated to one in which dairying and general mixed farming occupy prominent places. Grain raising has persisted in this part of the State longer than in most other parts and is still an important branch of farming. Practically all the general farm crops common to Wisconsin are grown in Pierce County, and agriculture is highly developed.

The most important crops in the county, considered as to acreage, are hay and forage, including all tame and cultivated grasses, wild grasses, grain cut green for hay, and other forage and silage crops. All these crops, taken together, were grown on 54,699 acres in 1919 and yielded 145,498 tons; the same crops in 1924 were grown on 68,812 acres and yielded 170,128 tons. In 1919 tame and cultivated grasses were grown on 42,736 acres and in 1924 on 47,023 acres. The oats crop, second in importance, was grown on 40,315 acres, and yielded 1,364,334 bushels in 1919, and in 1924 was grown on 47,791 acres and yielded 1,671,879 bushels. In this year 400 acres were cut green for hay. Wheat ranked third in importance in 1919, when an acreage of 22,840 acres yielded 322,694 bushels. In 1924, 6,096 acres yielded 139,010 bushels. Corn was grown on 20,106 acres in 1919 and yielded 898,522 bushels; and in 1924, of 36,647 acres grown 12,389 acres yielded 319,914 bushels of grain, 11,665 acres yielded 82,315 tons of silage, 8,539 acres were cut for fodder, and 4,054 acres were hogged off. Barley was grown on 17,406 acres in 1919 and on 19,565 acres in 1924, and rye on 10,818 acres in 1919 and on 7,642 acres in 1924. Other crops of less importance were buckwheat, flax, beans, peas, sugar beets, cabbage, potatoes, tobacco, strawberries, bush fruits, apples, pears, plums, and grapes. In the following table the acreage and yield of the principal crops are given for the years 1919 and 1924, as recorded by the Federal census:

Acreage and production of the principal crops in 1919 and 1924

Crop	1919		1924	
	Acres	*Bushels*	*Acres*	*Bushels*
Oats	40,315	1,364,334	47,791	1,691,879
Wheat	22,840	322,698	6,096	139,010
Corn	20,106	898,522	12,389	319,914
Barley	17,406	412,622	19,565	580,539
Rye	10,818	191,882	7,642	160,165
Buckwheat	373	6,130	168	2,820
Flaxseed	684	5,782	866	11,301
Potatoes	1,580	132,351	1,559	258,311
		Tons		*Tons*
Hay	43,662	86,145	48,208	73,585
Timothy alone	10,082	18,987	15,378	----------
Timothy and clover mixed	29,068	58,011	23,347	----------
Clover alone	2,815	6,009	3,917	----------
Alfalfa	294	775	3,083	----------
Other tame grasses	477	827	1,298	----------
Wild grasses	514	906	802	----------
Small grains cut for hay	346	518	325	----------
Annual legumes cut for hay	66	112	58	----------
Silage crops	4,853	45,295	11,665	82,315
Sugar beets	150	1,312	95	743
		Pounds		*Pounds*
Tobacco	97	115,151	175	188,998
	Trees	*Bushels*	*Trees*	*Bushels*
Apples	23,521	27,453	23,244	15,579

The following table shows the average acreage to the farm of the different crops in the various townships of the county. This table was compiled from observations in the field from the 1922 reports of the assessors of the different townships. These reports are on file at the office of the State department of agriculture and give the number of acres in each crop and the number of farms in each township. From these it was possible to get a close approximation to the average acreage of each crop on each farm.

Average acreage per farm of different crops in each of the townships in Pierce County

[Farms in villages not included]

Township	Corn	Oats	Barley	Rye	Wheat	Clover and timothy	Plowland used for pasture	Pasture land not plowed
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Clifton	24.5	24.2	18.7	15.9	6.6	17.6	8.2	23.3
Diamond Bluff	10.7	10.5	3.9	10.5	9.7	10.3	2.5	56.7
Ellsworth	10.0	14.9	2.9	6.9	.2	14.0	4.9	31.7
El Paso	10.5	16.4	4.1	2.5	.3	14.6	11.9	54.4
Gilman	7.0	12.1	3.0	.9	.07	17.3	.7	43.7
Hartland	11.5	15.8	6.4	7.3	2.4	13.2	5.3	----
Isabelle	9.0	10.8	2.1	12.7	11.3	11.2	3.2	35.7
Maiden Rock	9.0	11.4	8.6	8.6	5.9	16.4	4.6	47.1
Martell	12.2	17.1	5.6	2.9	1.6	19.1	5.9	50.5
Oak Grove	15.6	27.5	17.9	16.7	11.2	19.1	10.1	57.1
River Falls	13.5	23.4	7.4	8.3	.3	16.4	3.9	40.7
Rock Elm	11.2	15.8	6.6	1.2	.46	14.1	2.0	43.5
Salem	14.1	14.0	6.6	1.7	.25	2.7	9.7	54.4
Spring Lake	9.2	12.0	3.4	.2	.50	16.1	.1	59.1
Trenton	9.7	13.3	5.4	8.9	2.4	8.8	0	41.2
Trimbelle	10.2	13.9	6.1	6.9	.6	10.8	0	35.3
Union	11.0	14.1	11.3	2.8	.6	12.1	6	30.2

In Pierce County there is, in general, a gradual reduction in grain growing and an increase in dairying. There are several reasons why this region as a whole is better suited to dairy farming than to grain raising.

When grain growing is followed exclusively it is impossible to fully utilize the steep, stony slopes, but when dairying is followed these slopes are made use of as they supply good grazing. Thus the smooth land and more gentle slopes can be used for growing winter feed for the livestock, and pasture, which is a very important item to the dairymen, is provided by land which in a grain-growing program would not be utilized. Another factor favoring dairying in this region is that the steep slopes can be kept more permanently in grass, thus preventing soil erosion.

It is generally considered that corn does best on the dark-colored soils, and the largest acreages are grown in the townships where these soils predominate. The dark-colored soils are also well adapted to sugar beets, although the sugar content is not quite so high as that of beets grown on light-colored heavy upland soils. Many of the light-colored loams and silt loams, if some lime is applied, are well suited to alfalfa. Peas do best on light-colored soils such as Lindley, Clinton, and Bertrand silt loams. Tobacco is grown mostly on the silt loam soils but seems to do best where there is some fine sand mixed with the soil. In places cabbage is grown extensively on soils like Waukesha silt loam. The lighter-textured soils are considered best for trucking, and rye does better than other grains on the sandy soils of the county. Potatoes do best on sandy loams.

Hay is grown in all parts of the county and on a great variety of soils. The lowest yields are obtained on the light sandy soils and the best yields on the heavy soils. Timothy and clover mixed and alone make up the greater part of the hay crop. Because of the acidity of the soil, winter killing, and other causes, there has been some difficulty in establishing and keeping good stands of clover in places. The dark-colored soils, such as Carrington silt loam, Waukesha loam, and Waukesha silt loam, are generally acid, even where the limestone rock comes close to the surface. In spite of acidity and other unfavorable conditions, some very fine crops of clover, as well as many spotted fields, were observed during the progress of the soil survey. Where the stand of clover was poor the acidity was commonly high.

Alfalfa is a crop which is now receiving much attention in Pierce County. In 1919 the census reported 294 acres, but in 1924 the acreage had increased to 3,083.

The oats crop is well distributed over the county and is found on all soils. On the light soils the acreage is small, and yields are low. Oats do best on the heavier loam and silt loam soils of the county. The largest acreage of oats to the farm was found in Oak Grove Township.

In 1919, Pierce County ranked second in the State in the acreage of wheat. This crop is grown in all parts of the county and on most farms, though the average acreage to the farm is much lower than that of oats. The highest acreage to the farm is in Isabelle Township, where the average in 1922 was 11.3 acres. In Ellsworth Township there was an average of only 0.2 acre to the farm. This means that in Ellsworth Township many farmers raise no wheat at all. In this part of the county the dairy industry is highly developed. In such a district the acreage in wheat is commonly smaller than where dairying is less important.

Although corn is grown on a wide range of soils in all parts of the county, the acreage is largest on the dark-colored soils in the western part. In Clifton Township there was in 1922 an average of 24.5 acres to the farm in corn, and in Gilman Township the record shows only 7 acres to the farm. These are the two extremes. Clifton Township has a large area of dark-colored soil (Carrington silt loam), whereas Gilman Township has no dark-colored soil at all, the dominant soil types being Clinton silt loam and Lindley silt loam.

The two extremes in the acreage of barley are found in Clifton and Isabelle Townships. In Clifton Township the average was 18.7 acres to the farm and in Isabelle Township was only 2.1 acres to the farm in 1922. These differences in acreage must not be charged wholly to soil differences, as the type of farming, the personal likes and dislikes of the farmers, markets, labor conditions, and other factors frequently influence the acreage of crops.

Although rye does better on the light sandy soils than do any of the other small grains, it is grown in Pierce County on loam and silt loam soils in a number of places. The largest acreage to the farm is in Oak Grove Township, where the average was 16.7 acres to the farm. The smallest average, 0.2 acre to the farm, was in Spring Lake Township. On many farms in this and other townships no rye is grown.

Timothy and clover, alone or mixed, are grown most extensively in Martell and Oak Grove Townships, where the average acreage to the farm was 19.1 in 1922. The lowest average, in Salem Township, was only 2.7 acres to the farm.

The question of the utilization of steep land is important and is best solved where dairying is carried on. Some of the large areas of steep and rocky land in Pierce County are suited only for pasture. The townships having the most pasture land available would be expected to have the most livestock, and in a general way, this is true. In acreage of pasture land not plowed, Spring Lake Township leads, with an average of 59.1 acres to the farm. Diamond Bluff, El Paso, Martell, Oak Grove, and Salem Townships all have an average of more than 50 acres to the farm of unplowed pasture land. Clifton Township has the lowest average, with 23.3 acres to the farm.

The total acreage of a number of other crops is small, but locally these crops are of considerable importance. In 1922 sugar beets were grown most extensively in Clifton, Oak Grove, and Trimbelle Townships; cabbage was grown chiefly in Clifton, River Falls, Martell, Trimbelle, and Ellsworth Townships; flax had the greatest acreage in Maiden Rock, Gilman, Diamond Bluff, and Martell Townships; alfalfa was grown most extensively in Ellsworth, Salem, Diamond Bluff, Trenton, Hartland, and Trimbelle Townships; and tobacco was grown most extensively in Hartland, Salem, and Clifton Townships.

The raising of beef cattle is an important industry. In 1919 there were more than 16,000 beef cattle in this county, those of Shorthorn breed predominating. Animals of Red Polled, Hereford, and Aberdeen-Angus breeds are present in smaller numbers.

Dairy farming is gradually attaining a more important place on many of the farms in Pierce County. In 1919 there were 40,552 dairy cattle which produced 9,966,098 gallons of milk. The dairy herds are gradually being built up by the use of purebred sires, and the "boarders" are gradually being weeded out. Dairy cattle of the Holstein breed predominate, but some Guernsey and Jersey are kept. There are a number of purebred herds, but most of the cattle are grade stock. The 1925 farm census reports 49,944 head of cattle of all kinds in the county. These had a total value of $2,133,263.

A considerable proportion of the dairy output is in the form of butter and cheese. According to the assessors' report, 9 butter factories in the county in 1922 made 3,098,824 pounds of butter which had a value of $1,187,037.67. The same year, 8 cheese factories in the county produced 299,712 pounds of cheese, with a value of $49,763.98. In 1922, 21 receiving stations in the county collected more than 9,000,000 pounds of milk, with a value of $168,115.92, and 967,776 pounds of cream, with a value of $110,469.58.

It is generally considered that hog raising develops along with dairying, and in many places this is true. Pierce County, however, has fewer dairy cattle and more swine than have Waukesha and Waupaca Counties. According to the census there were 31,052 head of swine in Pierce County on January 1, 1920, and 33,180 head in 1925.

Sheep raising in Pierce County is an important branch of the livestock industry, but with the increase of dairying it is probable that the number of sheep may be reduced and the pasture used for more dairy cows. On account of the large acreage of steep land, however,

the raising of sheep to make full use of this class of land could well be continued and even increased. The census reports 15,871 head of sheep in the county in 1920 and 11,962 head in 1925.

The trucking industry has not developed to any marked extent in this county, chiefly because no large cities are near. Some special crops, including cabbage, sugar beets, tobacco, and a few onions, are grown. The fruit-raising industry has not been developed on a commercial scale, although some apple trees are found in small home orchards.

With very few exceptions agriculture is highly developed in all parts of the county. The farm buildings and equipment are, for the most part, modern and adequate for the demands of a highly developed farming community. The barns are large, well built, usually on a stone or cement foundation, furnish plenty of room for the dairy herd, and on many farms have the most modern stable equipment. The houses are comfortable. Most of them are equipped with telephones, and many farmers have furnace heat, running water, and electric light. In 1922 there were in the county 924 silos. The number is increasing each year. The same year there were in the county 264 farm tractors. Although the steepness of the land on many farms makes the use of a tractor difficult, the number in the county is on the increase.

In the sandy parts of the county, which are rather small in area, the farm buildings are not so good nor so well kept as in areas where the heavy soils prevail. Crop yields are lower, and livestock, tools, and all equipment show a less prosperous condition than on the heavy soils.

In 1920, of the 3,105 farms in Pierce County 1,093 were between 50 and 99 acres in size, 1,028 were between 100 and 174 acres, and only 7 included more than 1,000 acres. A few farms contained less than 50 acres and a few more than 175 acres but less than 1,000 acres. In 1920, 95.9 per cent of all the land in the county was in farms. Of this 60.5 per cent was improved. The average size of farms was 111.3 acres, and they averaged 67.3 acres of improved land. Of the farms in the county, 82.4 per cent, or 2,557, were operated by the owner, 518 were operated by tenants, and 30 were operated by managers. Of the rented farms, 318 were rented on shares and 150 for cash. The other renters had various agreements. Labor on the farms is generally American born and obtained from the immediate locality, During and after the World War, farm labor was scarce and very difficult to obtain and monthly wages varying from $60 to more than $75 were paid. Since that time there has been a decline in wages, but good farm labor is usually difficult to obtain. On farms where high-grade or purebred livestock is kept, a high grade of labor is required and good wages are paid. On many of the farms no hired labor is needed, as the members of the family do all of the work without outside assistance. On some farms the lack of adequate labor determines the type of farming which can be followed to best advantage.

Farm land in this county, as elsewhere, varies greatly in price, depending on the character of the soil, improvements, location with respect to public roads and schools, and other factors. The best farms on the good silt loam soils range in value from $150 to $200 an acre. On some of the lighter soils and where there is considerable rough land, some farms can be bought at prices varying from $25 to $50 an acre. The 1920 census reports the average value of all farm land

in the county, without buildings, as $75.47 an acre. The average value of land and buildings to the farm was then given as $11,339, or about $100 an acre for land and buildings.

SOILS

The well-drained soils of the uplands of Pierce County are predominantly light colored, the surface color in plowed fields being grayish brown or light grayish brown depending on the moisture content. This light color of the surface soil reflects the presence of a comparatively low percentage of organic matter. In uncultivated forested areas, the surface covering of leaf litter and leaf mold is rather thin, there is but little grass except in the more open wood lots and little humus is mixed with the upper mineral soil layers. When such land is cleared and plowed and cultivated for a number of years, the supply of organic matter is not sufficient to impart a very dark color to the surface soil.

In the northwestern corner of the county there are extensive well-drained uplands in which the soils are very dark colored, containing a large percentage of organic matter to a depth of 10 or 12 inches. These dark-colored lands were originally grasslands with very little or no tree growth. To this fact is attributed the high percentage of organic matter present and its incorporation with the mineral soil to a considerable depth. The surface soil of plowed fields is very dark brown or black, depending on the moisture content. A few small areas of similar dark-colored soil are located on the terrace or bench lands of Mississippi River.

The surface soil of more than 90 per cent of Pierce County is silt loam. To a depth ranging from 10 to 15 inches the upper soil layers consist of fine, friable, silt loam containing 50 or 60 per cent of silt. The subsoils are somewhat heavier than the surface layers but are neither extremely heavy nor compact. The substratum material or parent material is extremely variable. It consists of residual material from limestone, shale, and sandstone, and of glacial drift, loess, and alluvial material in the form of terraces and stream bottoms composed of recently deposited alluvium.

Glacial drift is unconsolidated material formed from many kinds of rock, accumulated and transported by the ice sheet. In this region, sandstone and limestone form the bedrock, but to the north there are large areas of crystalline rocks which also have contributed to the composition of the glacial drift.

Loess consists of particles of fine silt. It has a uniformly fine texture and smooth feel. The layer of this material in Pierce County ranges from a few inches to 20 or more feet in thickness. It is deepest along Mississippi River and thins out as the distance from the river increases. In Gilman Township, evidences of glaciation in the form of gravel ridges, stones, and bowlders are plentiful. In the southern part of the county, glacial gravel is seen in places in road cuts which are deeper than the loessial blanket.

Extensive terraces occurring at various elevations along Mississippi River are built up largely of stratified sand and gravel. Some of these deposits were probably laid down during glacial times when melting ice contributed to the volume of water. Large areas of land

within the present flood plain consist of material of recent deposition. In the valleys of some of the smaller streams some terrace and first-bottom land occur, but these areas are small and of little importance.

In the soil survey of Pierce County the soils have been classified in 13 soil series including 19 soil types and 3 phases, in addition to the miscellaneous classifications of land—alluvial soils, undifferentiated, river wash, and rough stony land.

The Clinton series includes the predominant light-colored upland soils derived largely from loess. Clinton silt loam, with a steep phase, is mapped.

The Lindley series includes light-colored soils, originally forested, derived from old glacial material over which the loessial blanket is very thin or entirely lacking. Lindley silt loam, with a steep phase, and Lindley fine sandy loam were mapped.

The Carrington series includes dark-colored, well-drained upland prairie soils in which the material was largely of glacial origin. Carrington silt loam and Carrington fine sandy loam were mapped.

Thurston gravelly loam has a dark-brown gravelly surface soil, a reddish-brown heavier subsoil, and a noncalcareous gravel substratum. It is the only member of the Thurston series mapped.

The Dubuque series includes soils which have been developed by the weathering, in place, of the underlying limestone, influenced, possibly, by shale. These soils are of very small total extent. Only Dubuque silt loam was recognized in this county.

The Boone series includes light-colored upland soils, originally forested, the material of which has been derived largely from sandstone and shale associated with the sandstone. Boone silt loam, Boone fine sandy loam, and Boone fine sand were mapped.

The Conover series includes light-colored upland soils which commonly occur on gentle slopes where the drainage is imperfect. The subsoil is heavy in texture and is mottled. Conover silt loam was mapped.

The Clyde series includes dark-colored soils occupying poorly drained depressions in the glacial upland country. In some places alluvial material has been mapped with the Clyde soils. Clyde silt loam was mapped in Pierce County.

The Bertrand soils have light-colored surface soils, yellowish-brown heavier-textured subsoils, and substrata consisting typically of fine-textured, water-laid deposits. These soils occur on river terraces. Bertrand silt loam and Bertrand loam are mapped.

The Waukesha series includes dark-colored soils, formed of water-laid material. They occur on stream terraces. This land was originally largely prairie land, and most of the soils are acid. Waukesha silt loam and Waukesha loam were mapped.

The La Crosse series includes rather dark-colored soils which occur on stream terraces or outwash plains. They were derived from water-laid glacial drift. La Crosse fine sandy loam, dark-colored phase was mapped in Pierce County.

The Sparta series is represented in this county by Sparta sand. The surface soil is dark-gray sand from 12 to 18 inches thick. The subsoil and substratum consist of loose, gray sand.

The Genesee series includes light-colored first-bottom lands within the present flood plains of streams. The material is largely recently

deposited alluvium. It is added to by each overflow. Genesee silt loam and Genesee sandy loam were mapped.

Along Mississippi River are areas of recent-alluvial soils, mostly poorly drained, of variable composition, and subject to frequent flooding. These were mapped as alluvial soils, undifferentiated.

River wash consists of alluvium which has been so recently deposited that there is little vegetation on it. Though there is a considerable range in its texture, most of the material is very sandy or gravelly.

Rough stony land includes steep, rough, and stony or rocky land which can not be cultivated. It forms the steep walls of valleys and is very extensive in this county.

In the following pages of this report the soils of the county are described in detail and their agricultural characteristics are discussed; the accompanying map shows their distribution in the county; and the following table gives their acreage and proportionate extent:

Acreage and proportionate extent of the soils mapped in Pierce County, Wis.

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Clinton silt loam	136,448	41.4	Bertrand silt loam	7,296	1.9
Steep phase	19,072		Bertrand loam	1,600	.4
Lindley silt loam	76,224	22.6	Waukesha silt loam	640	.2
Steep phase	8,640		Waukesha loam	1,408	.4
Lindley fine sandy loam	12,992	3.5	LaCrosse fine sandy loam, dark-colored phase	4,096	1.1
Carrington silt loam	8,320	2.2			
Carrington fine sandy loam	512	.1	Sparta sand	4,864	1.3
Thurston gravelly loam	1,792	.5	Genesee silt loam	19,136	5.1
Dubuque silt loam	4,800	1.3	Genesee sandy loam	4,352	1.2
Boone silt loam	2,304	.6	Alluvial soils (undifferentiated)	4,288	1.1
Boone fine sandy loam	4,032	1.1	River wash	320	.1
Boone fine sand	2,944	.8	Rough stony land	45,312	12.1
Conover silt loam	1,408	.4			
Clyde silt loam	2,240	.6	Total	375,040	

CLINTON SILT LOAM

In cultivated fields, the surface soil of Clinton silt loam consists of grayish-brown, smooth, friable silt loam, 8 inches thick. Between depths of 8 and 16 inches the material is light yellowish-brown silt loam. Between depths of 16 and 30 inches is light yellowish-brown silt loam which is heavier and more compact than either the layer above or the layers beneath. Below a depth of 30 inches the material is unweathered loess, light yellow in color and composed almost entirely of silt and very fine sand. This silty material continues to a depth ranging from 3 feet to more than 20 feet and rests on the underlying rock, on residual material from the underlying rock, or on a thin layer of old glacial drift.

This soil is uniform in color, texture, and structure but has a few minor variations. In depressed areas more organic matter than typical is present. This imparts a dark-brown color to the surface soil. Over some nearly level areas or on gentle slopes the drainage is somewhat deficient, and the subsoil is mottled. In places the subsoil seems to contain more clay than typical. This condition is more prevalent in the northern areas of the soil where it is associated with Lindley silt loam.

Clinton silt loam is the most extensive soil in the county and is the most important from the viewpoint of agricultural production. It

is the predominant soil in the southern half of the county and in the eastern part and is mapped to some extent in nearly every township. Many farms are made up entirely of this soil.

Areas of this soil vary from nearly level to gently rolling and hilly. Most of the land is undulating or gently rolling. The level or gently undulating areas are less extensive, and the steep areas are least extensive. The very steep land is separately indicated on the soil map as a steep phase. For the most part, the soil occurs on the elevated plateaulike areas and extends down the upper slopes to areas of rough stony land which form the steep valley walls. In a few places small areas of this soil were mapped on the lower slopes below the rough stony land areas. This land is practically stone free, but it grades to Lindley silt loam, which contains some stones and bowlders.

Clinton silt loam, in this county, is generally acid in the surface soil. Leaching has carried out most of the lime to a depth of 5 or 6 feet, but below this there is commonly enough lime present to give an active reaction with dilute hydrochloric acid. In places there is segregation of lime carbonate to form little, rounded nodules and tubular bodies. In road cuts where tests were made of the material 15 or 20 feet below the surface, there was practically everywhere a reaction with hydrochloric acid, showing the presence of lime carbonate.

The original timber growth on this soil consisted of hard maple, oak, basswood, elm, hickory, and some walnut. Maple trees seem to predominate in many places along the Mississippi River bluffs and for several miles back from the river, but beyond that the oaks are more plentiful, and on the northern areas oaks predominate. A considerable number of farm wood lots are on this soil. In Rock Elm Township, where this soil predominates, about 4,000 acres are in farm wood lots. Many of them are on land which, when cleared, will make good farming land.

It is estimated that from 75 to 80 per cent of the Clinton silt loam is cleared and under cultivation, and the greater part is highly improved. The chief crops are hay, oats, wheat, corn, and barley. While the survey was in progress some excellent fields of clover were seen, even where the soil showed some acidity. The productivity of such fields seemed to be high. On many fields where the productivity seemed to be low, clover showed a spotted appearence, the acidity having a greater effect on the crop. The large acreage of alfalfa on this soil is being rapidly extended. Lime is usually used to establish a good stand. Flax is grown to some extent. In Maiden Rock Township 252 acres were planted to this crop in 1922. In this township Clinton silt loam is the predominant soil type. Union Township that year raised 94 acres of flax and Gilman Township 63 acres. These are the three leading flax-growing townships in the county. This crop is commonly grown on new land and is sometimes seeded with wheat. It seems to be more profitable to grow these two crops together than to raise them separately. General farming and dairying are the important types of agriculture followed. Sugar beets are not grown so extensively on this soil as on some of the other soils in the county.

The raising of grain is still an important industry, though the acreage of wheat is gradually being reduced. Probably less wheat is

grown on this soil than on some of the other soils in the county. In Union Township, where this soil predominates, the average acreage to the farm of the chief crops is as follows: Corn, 11 acres; oats, 14.1 acres; barley, 11.3 acres; rye, 2.8 acres; wheat, 0.6 acre; clover and timothy, 12.1 acres; plowland used for pasture, 6 acres; and land never plowed, used for pasture, 30.2 acres. In addition to these, a number of acres of less important crops such as peas, flax, root crops, and alfalfa are grown, and some of the land is in wood lots. In this township the land used for these purposes amounts to about 26 acres to the farm. Potatoes are grown chiefly for home use.

In the improvement of this soil, careful tests of the soil and crop observations should be made to determine the need of lime and commercial fertilizers. As much of the soil is acid, the use of lime should be largely increased. The tests and examinations made by the State soils laboratory show that this soil will respond to superphosphate (acid phosphate) and to mixed fertilizers rich in phosphorus, as this element seems to be present in too small quantities for maximum crop production.

In the cultivation of the steep slopes of this soil, care should be taken to prevent erosion. A good supply of organic matter helps control washing, and proper cultivation is essential. Steep slopes, where timbered, should be left in timber and where cleared should be kept in permanent pasture if possible. Crop rotations are an important factor in agriculture, and those best suited to the soil conditions should be selected.

Clinton silt loam, steep phase.—The steep phase of Clinton silt loam differs essentially from the typical soil in its topographic position. It occurs with rough stony land on steep slopes which form the valley walls and heads of small streams of the county. In these areas, the silty upper layers are generally thinner than in typical Clinton silt loam and where erosion has been active, may be absent. Most of this soil is farmed.

The following table gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Clinton silt loam:

Mechanical analysis of Clinton silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
3138116	Surface soil, 0 to 4 inches	0.1	0.2	0.1	1.4	31.3	59.0	7.4
3138117	Subsurface soil, 4 to 14 or 16 inches	.0	.2	.0	.8	29.8	59.2	9.5
3138118	Subsoil, 14 to 36 inches	.0	.0	.0	.8	30.0	56.1	13.2
3138119	Subsoil, 36 to 72 inches	.0	.0	.0	.4	38.4	52.7	8.8
3138120	Subsoil, 72 inches+	.0	.0	.0	.4	44.6	50.1	4.7

LINDLEY SILT LOAM

In cultivated fields the surface soil of Lindley silt loam, to a depth of 8 inches, is grayish-brown silt loam. Between depths of 8 and 14 inches the material is light yellowish-brown silt loam. Between depths of 14 and 22 inches is yellowish-brown heavy silt loam or silty clay loam, very slightly mottled in places and containing a few glacial pebbles. This layer is more compact than that above. Below a depth of 22 inches, the material is yellow or yellowish-brown glacial till consisting of gravelly or sandy clay.

The thickness of the smooth, silty upper layers varies in a number of places. Where the soil borders Clinton silt loam, the silt covering is in many places about 3 feet thick, and the line between the two soils is an arbitrary one. In other places, especially in Gilman Township, the glacial till comes almost to the surface and crops out in many places in the form of gravel knolls. Stones and bowlders are common on this soil, but in only a few places are they sufficiently numerous to interfere with cultivation. In such places they have been gathered together in piles.

Lindley silt loam is most extensive in the northern tier of townships. Probably the largest and most continuous area is in Gilman Township, where this is the predominant soil. Lindley silt loam is also the most extensive soil in the townships of Martell, River Falls, and Clifton. It is present in El Paso, Ellsworth, Trimbelle, and Oak Grove Townships, but not in such extensive areas. This is the second most extensive soil in the county and is important agriculturally.

The surface of Lindley silt loam varies from level to steeply rolling, but the greater part is gently rolling or rolling. Because of the surface features and the nature of the subsoil, the natural drainage is in most places good. Less well-drained areas, having somewhat mottled subsoils, are about the heads of streams where the land is nearly level or gently sloping. Where such areas or other depressed areas were of sufficient size they were mapped as Conover silt loam.

Lindley silt loam is derived, for the most part, from glacial till of pre-Wisconsin age. The surface soil and subsoil both show an acid reaction, and free lime was absent even at a depth of 5 or 6 feet.

The original timber growth was largely of oak of several varieties, of hickory, elm, and some ash and maple. A large part of the merchantable timber has been cut, but a number of wood lots remain, and some steep, rocky slopes support good stands of timber.

The greater part of the Lindley silt loam is cleared and under cultivation. It may be classed as a good agricultural soil, fully equal to Clinton silt loam in agricultural value. It is, for the most part, highly improved and is well suited to the production of all farm crops common to the region. Dairying is the chief type of farming followed. Corn, alfalfa, small grain, and sugar beets are successfully grown. The acreage of small grain is not so large as it formerly was, but the corn and alfalfa acreage is increasing with the development of dairying.

In the improvement of this soil, liming is important, especially where clover and alfalfa are grown. The supply of organic matter should be increased, and the use of phosphatic fertilizers has, by test, proved to be profitable.

Lindley silt loam, steep phase.—The steep phase of Lindley silt loam comprises those areas which lie on the steep slopes of valley walls and valley heads. This soil is mostly nonarable and is used for pasture and timberland.

LINDLEY FINE SANDY LOAM

The surface soil of Lindley fine sandy loam, to a depth of 7 inches, consists of medium-brown fine sandy loam. Between depths of 7 and 16 inches the material is lighter-brown fine sandy loam which, at a depth of 16 inches, grades to yellowish-brown, coarser material. Below a depth of 24 inches is a layer of sandy clay loam which grades,

at a depth of about 36 inches, to sandy loam. The subsoil in many places contains some fine gravel and stones. The sandy clay loam layer varies to a considerable degree in thickness. In some places it is very thin, and in others it continues to a depth greater than 3 feet.

Included with Lindley fine sandy loam are a few small areas of Lindley loam, in which the surface soil is loam in texture.

Lindley fine sandy loam is of small total extent but is widely scattered. It occurs chiefly in the townships of Gilman, Salem, Trimbelle, River Falls, Clifton, and Oak Grove. It is associated chiefly with Lindley silt loam and to some extent with the Boone soils. The largest areas are in the valley of Kinnikinnic River.

Areas of this soil vary from gently sloping to gently rolling, and the natural drainage is good. In some places, where the soil is lighter than typical in texture, the drainage is excessive. This soil is more likely to suffer from drought than Lindley silt loam.

Lindley fine sandy loam is derived chiefly from glacial drift, but nowhere does it occur very far from sandstone formations from which the parent material has been in part derived through glacial action. Both the surface soil and subsoil are acid.

The native vegetation consisted of mixed hardwood and a little pine. A few wood lots and scattered clumps of trees remain, but most of the merchantable timber has been cut.

This soil is mostly cleared and cultivated. It is fair or good farming land and is fairly well suited to the crops commonly grown in this region. Where markets are within reach, it could best be devoted to special truck crops, to which it is well adapted. In growing clover or alfalfa, lime should be used, and the supply of organic matter should be increased. This soil shows from tests that it will respond profitably to the use of superphosphate (acid phosphate). In general, the methods of improvement suggested for Lindley silt loam apply to this soil.

CARRINGTON SILT LOAM

The surface soil of Carrington silt loam, to a depth of 10 inches, is smooth silt loam, dark brown in color when dry and black when moist. Between depths of 10 and 20 inches the material is brown silt loam, which in many places becomes heavier in the lower part of the layer. Between depths of 20 and 34 inches is light-brown or yellowish-brown heavy silt loam or silty clay loam. Below this layer is heavy-textured glacial drift. Carrington silt loam is very uniform in most respects, but in places, especially on slopes, the color is lighter brown than typical. The surface soil and subsoil are acid in reaction, as the underlying drift is noncalcareous.

Carrington silt loam occurs exclusively in the western part of the county, chiefly in the townships of Clifton and Oak Grove. It is not extensive, but its high productivity makes it agriculturally important.

Areas of Carrington silt loam range from nearly level to gently rolling, and the natural drainage is good. A very few bowlders are seen on the surface. All of the land is so situated that modern farm machinery can be used.

Carrington silt loam is locally known as a prairie soil, and part of the land was no doubt treeless. In places, however, there was a

scattered growth of trees. Much of the native vegetation was rank grass, the decay of which, from year to year, is responsible for the dark color and high humus content of the soil.

Carrington silt loam is considered one of the best soils in the county and is highly prized for its fertility. It is well adapted to all crops common to the region and is all highly improved.

In the higher improvement of this land, lime should be used, especially for clover and alfalfa. The soil responds well to the use of phosphatic fertilizers. Dairying is now on the increase, so that larger quantities of manure are available than ever before. Sugar beets are grown more extensively on this than on any other soil in the county, and considerable cabbage is grown. Both these crops do well.

CARRINGTON FINE SANDY LOAM

The surface soil of Carrington fine sandy loam, to a depth of 8 inches, consists of dark-brown or nearly black fine sandy loam. Between depths of 8 and 22 inches the material in most places is light-brown fine sand, although in some places the lower part of the subsoil contains considerable clay loam or sandy clay loam. This soil is somewhat variable, ranging from silt loam or loam to light, fine sandy loam.

Carrington fine sandy loam is not extensive. It occurs in the western part of the county, chiefly in River Falls and Clifton Townships. It is associated with Carrington silt loam and in places with the Boone soils. The surface ranges from nearly level to gently rolling, and the natural drainage is good.

This soil is locally known as prairie land, and doubtless much of it was treeless. However, a part of it was forested. It supported a good growth of grass, the decay of which accounts in part for the high organic-matter content and the dark color of the surface soil.

Carrington fine sandy loam is derived mostly from glacial drift, though some of it, which lies over or is adjacent to sandstone formations, may have been derived in part directly from residual material from sandstone rock. Both surface soil and subsoil are acid.

Carrington fine sandy loam is a good farming soil and is well suited to all crops common to the region. It can be worked under a wider range of moisture conditions than Carrington silt loam but is not quite so productive. It is well suited to truck crops, and where market conditions are favorable it could well be used for this type of agriculture. At present most of it is used for general farming.

In the improvement of this soil, the suggestions made for Carrington silt loam apply.

THURSTON GRAVELLY LOAM

In cultivated fields the surface soil of Thurston gravelly loam, to an average depth of 7 inches, consists of brown or dark-brown gravelly loam. Between depths of 7 and 20 inches the material is reddish-brown gravelly loam. From a depth of 20 inches to more than 36 inches is fine gravel containing some sand and in places a little clay. The soil varies somewhat, chiefly in the depth to the gravel bed, but the covering of fine-textured soil is in most places sufficient to cause the soil to be classed as agricultural.

Thurston gravelly loam is of very small total extent. It includes numerous small knolls which are very conspicuous and many of which

are stony as well as gravelly. Thurston gravelly loam occurs principally in the northern part of the county where evidences of glaciation are most pronounced. The areas are most numerous in Gilman Township, where more than 20 separate areas were mapped. These vary in size from a few acres to about 80 acres. Some patches are too small to be shown on the map. This soil is closely associated with Lindley silt loam and is found in most of the townships where Lindley silt loam is mapped.

The surface of this soil is broken by knolls and hummocks and is very irregular. Modern farm machinery, however, could be used. Because of the irregular surface and open, gravelly subsoil, the natural drainage is good.

The parent material is noncalcareous gravelly till, thoroughly leached of any lime carbonate which it may have contained. The surface soil and subsoil are both acid.

The native timber growth consists chiefly of oak and hickory. The best timber has been cut, but a number of wood lots remain. In many of the hills gravel pits have been opened, and gravel for road material has been taken out. This is of good quality and gives much of the land a value greater than its agricultural value.

Fully half of the Thurston gravelly loam is cleared and utilized in some way, mostly for pasture. Some is cultivated, but crops are apt to suffer during dry spells.

DUBUQUE SILT LOAM

The surface soil of Dubuque silt loam, to a depth of 7 inches, is light-brown friable silt loam. Between depths of 7 and 14 inches the material is yellowish-brown, heavy silt loam, in places mottled with gray. Between depths of 14 and 24 inches is brown clay loam showing a greenish tint. Below a depth of 24 inches is yellowish-green or light brownish-green clay, resting on limestone at a depth of about 90 inches. Typically, the surface is stone free, but on some areas a few glacial bowlders are found. The surface soil is commonly darker than that of Lindley silt loam. Many areas have a brick-red subsoil, and not all show the greenish cast which is typical in this county. The depth of the silty covering over clay is very variable.

Dubuque silt loam is small in extent but is distinct in character. It is associated chiefly with Lindley silt loam in rather small patches, many of them being less than 40 acres in extent. It occurs chiefly in the townships of Martell and River Falls.

Areas of Dubuque silt loam range from level to gently rolling, and in some places the soil occurs on flat-topped hills or elevated, benchlike situations. The natural drainage is fair, but where the surface is level the soil is rather backward in spring on account of deficient drainage. Where the surface is gently rolling the surface drainage is nearly as good as on Lindley silt loam, but the internal movement of water is slower.

For the most part this soil is residual from limestone with which is associated some shale which may have contributed to the formation of the clay subsoil. The presence of glacial bowlders seems to indicate that part of the soil may be derived from glacial drift. The surface soil is commonly acid.

The timber growth on this soil was chiefly of oak, hickory, elm, and some maple. Although some wood lots remain, most of the soil which

is productive has been cleared and placed under cultivation. Corn is probably as well adapted to it as any crop. Yields are about the same as on Lindley silt loam, though they are higher in dry years and lower in wet years, as this soil is inclined to be cold and backward in the spring. Small grains and grasses do well. This may be considered a good general-farming soil, though it is somewhat more difficult to manage than Lindley silt loam or Clinton silt loam. In the improvement of Dubuque silt loam, the suggestions outlined for Lindley silt loam and Clinton silt loam apply.

BOONE SILT LOAM

In cultivated fields the surface soil of Boone silt loam, to a depth of 8 inches, consists of grayish-brown silt loam which closely resembles Clinton silt loam in color. Between depths of 8 and 24 inches the material is gray silt loam, loam, or fine sandy loam. Below a depth ranging from 24 to 36 inches is the underlying rock, which consists of sandstone or shaly sandstone. In some places the soil is more than 3 feet thick; in others bedrock is present within 2 feet of the surface. The soil material is largely residual from shaly sandstone.

This soil occurs almost exclusively in Rock Elm Township, chiefly in sections 17, 20, 21, 28, 29, 30, 31, and 33, where its total area is several square miles. The surface ranges from rolling to hilly, and the natural drainage is good.

The timber growth consists largely of oak of several varieties, with some maple and hickory and a little basswood, and some elm in lower places. Some of the timber is merchantable. Probably half of the soil is cleared, but it is inferior to Clinton silt loam. Crops do not look so well, and farms are not so prosperous as on Clinton silt loam or Lindley silt loam. General farming is practiced, and all crops common to the region are grown. Because of the uneven surface, the soil is more difficult to cultivate than either Clinton silt loam or Lindley silt loam. The suggestions made for the improvement of Clinton silt loam apply to this soil.

BOONE FINE SANDY LOAM

In cultivated fields the surface soil of Boone fine sandy loam, to an average depth of 8 inches, consists of brown fine sandy loam. Between depths of 8 and 22 inches is brown fine sandy loam, a little lighter in color than the surface soil. Between depths of 22 and 40 inches is yellowish-brown fine sand or fine sandy loam underlain, at a depth of about 36 inches, by yellow fine sand.

This soil is variable in texture, the surface soil ranging from fine sand to heavy loam. It generally occurs in narrow strips between rough stony land above and Lindley silt loam below. The soil at the upper edges of these strips is generally fine sandy loam or fine sand; toward the lower boundary it merges into silt loam. Sandstone fragments are mixed with the soil in places.

This soil is of rather small total extent in Pierce County. It occurs chiefly in the townships of Clifton, River Falls, Oak Grove, Martell, Maiden Rock, Salem, and Trimbelle. It lies at the foot of ridges, from 40 to 50 feet high, composed of St. Peters sandstone and capped by a thin layer of Galena limestone. The surface is sloping and natural drainage is good. The soil material has been derived largely

from the disintegration of St. Peters sandstone. It is typically residual material, but some of it has no doubt been moved by ice or water. The material is noncalcareous, and both surface soil and subsoil are acid.

The native timber was largely of mixed hardwoods among which oak predominated, but some white pine was present.

Most of this soil is cleared and under cultivation. It is devoted to general farming and gives fair returns. It is well adapted to special crops and where markets are favorable should be devoted more largely to trucking. It warms up early in the spring, is easily worked, and responds quickly to proper fertilization. It needs lime and phosphatic fertilizers.

BOONE FINE SAND

Boone fine sand consists of a layer of light-brown fine sand or loamy fine sand, 6 inches thick, underlain by yellow fine sand which continues to a depth of more than 3 feet. The soil varies to some extent in color and texture, but on the whole it is very uniform.

This soil occurs only where sandstone forms the surface rock. Most of the areas are in the northwestern part of the county. None are large, but they are distributed rather widely over the townships of River Falls and Clifton, and some are in El Paso, Salem, and Spring Lake Townships.

The surface of many areas is steeply or gently sloping. Limestone occurs in places higher up on the slopes and caps some of the hills. Many of the upper slopes consist of fine sand, but the lower slopes are somewhat loamy in the surface layer. Because of the sloping surface and sandy texture of the soil, the natural drainage is excessive and the soil suffers from drought.

Boone fine sand is formed from material consisting largely of disintegrated sandstone, some of which may have been moved by the ice sheet. The material is noncalcareous and both surface soil and subsoil are acid, except in places where water from limestone formation above brings down lime. The lime has a tendency to neutralize the acidity and make possible the more successful growing of alfalfa.

The native timber was mostly of scrub oak, though there was originally some pine. The remaining growth is very scrubby and is of little value except as fuel.

This is a soil of rather low agricultural value, but most of it is cleared and in farms. It is devoted chiefly to general farm crops, though it is better adapted to special truck crops. In its improvement it should be limed and supplied with more organic matter and mineral plant foods.

CONOVER SILT LOAM

In plowed fields the surface soil of Conover silt loam, to a depth of 8 inches, consists of grayish-brown or light grayish-brown silt loam. Between depths of 8 and 28 inches is mottled gray and brown heavy silt loam which becomes heavier and more mottled with depth. Between depths of 28 and 36 inches the material is very mottled, reddish-yellow and brown clay loam which in places below a depth of 3 feet grades to sandy loam or sandy clay. This soil resembles Lindley silt loam in some respects but differs by being strongly

mottled. It is very uniform in surface texture and color, the grayish-brown color being predominant.

Conover silt loam is associated with both Lindley silt loam and Clinton silt loam. It is most extensive in the township of Ellsworth where there are more than a dozen areas, ranging in size from 20 to 175 acres. Small areas are found in other townships of the county.

The surface is level or gently sloping, and the soil occurs in small depressions or on gently sloping land around stream heads where there may be some seepage. Because of its position and the heaviness of the subsoil, the natural drainage is deficient. The surface soil and upper part of the subsoil are acid.

The timber growth native to this soil is oak, elm, ash, and some maple. Most of the trees have been cut, but in a few lots there is still some good merchantable timber. By far the greater part of this soil is cleared and under cultivation. Where well drained it gives fair returns, but drainage over most areas is deficient and the soil is cold and backward and is best suited to grass crops and hay. It is used with Lindley silt loam and Clinton silt loam for general farm crops, but yields of corn and small grains, because of deficient drainage, are frequently lower than on these soils.

Drainage is important in the improvement of this soil. Tile drains could be installed with profit in numerous places, but little tiling has been done. The soil needs lime and will respond to phosphatic fertilizers.

CLYDE SILT LOAM

The surface soil of Clyde silt loam, to an average depth of 7 inches, consists of black, smooth silt loam having a high organic-matter content. Between depths of 7 and 20 inches the material is black silty clay loam and between depths of 20 and 40 inches it is dark-gray and yellow mottled silty clay loam. This soil varies somewhat as to color and depth to the mottled subsoil and also as to the content of organic matter. In a few places the surface soil resembles muck.

Clyde silt loam is of small total extent. It occurs in a number of patches ranging in size from a few acres to one-half section. It is most extensive in the northern and central parts of the county. Areas are level and generally depressed, and the natural drainage is deficient. Much of the soil occupies saucer-shaped depressions in the upland or occurs along stream channels as low bottom land, part of which is subject to overflow. Most of the soil, however, is not subject to flooding.

Typical Clyde silt loam, like Lindley silt loam, is derived from glacial drift. It occupies low and poorly drained areas, where the large amount of organic matter present imparts a dark color to the soil. Poor drainage has retarded oxidation, and a mottled condition in the subsoil has resulted. The present material is noncalcareous, and both surface soil and subsoil are in most places acid.

The native timber growth consisted chiefly of ash, elm, soft maple, and willow. Coarse grasses thrived. Most of the timber has been cut, and the greater part of the soil is used as permanent pasture. In a few places where drainage conditions are better than the average the soil is cultivated. Where it is well drained it is highly productive. In southern Wisconsin well-drained Clyde silt loam is the best cornland.

In the improvement of this soil, drainage is the first and most important step to be taken. Drained land of this kind is well suited to a wide range of crops. Tile should be used for drainage rather than open ditches. In many places one line of tile through the center of a depression would be sufficient.

BERTRAND SILT LOAM

The surface soil of Bertrand silt loam consists of dark-brown or dark grayish-brown silt loam about 3 inches thick. This is underlain by grayish-brown or yellowish-brown silt loam which in most places extends to a depth of about 15 inches where it grades to yellowish-brown silty clay loam. This heavy layer extends to a depth of 3 or more feet. In the lower part the material is not quite so heavy and contains less clay and more silt. At a depth of 4 or 5 feet layers of sand are present. In a few places the soil was found to rest on sandstone at a depth varying from 3 to 5 feet. This condition does not appear to be very common. Where cultivated, the upper layers become mixed, resulting in a grayish-brown silt loam surface soil.

The surface soil is subject to some variation in color. In some places it is very dark and resembles Waukesha silt loam. In a few small areas the subsoil is mottled and resembles that of Conover silt loam. Most of these variations are of small extent.

In some areas the sandy or gravelly material comes to within about 2 feet of the surface. The gravelly subsoil occurs mostly in the north-central part of the county, where glacial action was most pronounced. Where the soil borders the stream courses, the lower part of the material is similar to Genesee silt loam, better-drained phase, and in places the heavy layer in the subsoil is lacking. The soil in such places may be subjected to overflow. Some of the narrow areas of Bertrand silt loam include areas of Genesee silt loam.

Bertrand silt loam occurs in many of the stream valleys of the county. The largest area is in the valley of Mississippi River, northwest of Bay City. Numerous areas are along Plum Creek above and below Plum City, and others are along Cady Creek, Eau Galle River, and some of the other streams of the county.

Bertrand silt loam occurs mostly on stream terraces. The surface is for the most part level or gently sloping toward the stream channel along which it occurs. In a few places the land is undulating. In general, drainage is good, but where the soil occurs along intermittent streams or where it borders Genesee silt loam small areas may be subject to flooding. The water never stands long on the surface as the stream flow is very fast.

Bertrand silt loam is derived from water-laid material. The material does not effervesce with acid within 3 feet of the surface and no tests were made of the deeper material. It is doubtful if the deep subsoil layer contains lime. The surface soil is slightly acid, and the soil responds to the use of lime.

This soil supported a natural growth of maple, oak, elm, basswood, and hickory, but most of the timber has been cut. The greater part of the soil is under cultivation and forms parts of well-improved farms. Very few farms are made up entirely of this soil, as the stream valleys are long and narrow and usually only portions of the many farms are in the valleys. This is a productive soil and is classed as

choice land. It retains moisture well, is easy to cultivate, and works easily into a good seed bed.

The principal crops grown are corn, hay, and small grain. The methods of farming used are similar to those followed on Clinton silt loam. Some alfalfa is grown, and the acreage is increasing. Where the farm buildings are located in the valley, as they are on many farms, the manure is most often used in the valley, and the fertility of the valley soil seems to be greater than of that on the hills.

In the improvement of this soil, lime should be used in places, especially for alfalfa. Where limestone bluffs border the terrace, wash from the limestone in places is sufficient to keep the soil in a good condition. It has also been found that this soil will respond to the use of superphosphate (acid phosphate).

BERTRAND LOAM

In cultivated areas the surface soil of Bertrand loam consists of grayish-brown or brown loam 14 inches thick. This is underlain by brown loam or silt loam which continues to a depth of about 28 inches where it grades to more yellowish material containing lenses of fine sand. This soil is very variable. Lenses of fine sand may be found within 18 inches of the surface and in some places gravel is present, especially in the north-central part of the county where glacial soils are most extensive. In Rush River Valley gravel often underlies Bertrand loam. The deep part of the subsoil may be loam or sandy loam, or it may be sandy or gravelly material. The surface soil ranges from light-textured silt loam to fine sandy loam, and the subsoil is also variable.

This soil is most extensive in the townships of Spring Lake and River Falls. Most of the areas comprise less than 160 acres, and but few if any farms are composed entirely of this soil.

Areas of Bertrand loam are level or very gently sloping or undulating, and natural drainage is good. The soil may suffer to some extent during long dry spells, especially where the sand or gravel is close to the surface.

The soil material is of alluvial origin and occurs on benches or terraces along stream courses. The surface soil and subsoil are commonly acid and respond to the use of lime.

The original timber consisted chiefly of hardwoods with a little pine. Practically all of the merchantable timber has been cut and the land cleared and placed under cultivation. This is a soil which works easily and responds to the use of fertilizers and careful treatment. The crops grown, yields obtained, and the methods followed are about the same as on Bertrand silt loam.

This soil as a whole is well drained, but during floods some parts are subject to overflow. In many places areas border the Genesee soils, which are subject to overflow, and the line between these soils is not always well defined. Flood water never stands on the land for any length of time and seldom interferes with or destroys crops.

WAUKESHA SILT LOAM

The surface soil of Waukesha silt loam, to a depth of 12 inches, consists of dark-brown or black, smooth, friable, silt loam. Between depths of 12 and 26 inches the material is brown silt loam, and bebetween depths of 26 and 36 inches it is yellowish-brown heavy silt

loam or very fine sandy loam underlain by very fine sandy loam at a depth of 42 inches. This soil is underlain by sandy material which occurs at variable depths. In a few places gravelly material is mixed with the sand in the substratum. Some variation in color occurs, but the soil is everywhere darker than the Bertrand soils.

Waukesha silt loam is of very small extent. The largest area in the county, in the township of River Falls, occurs on terraces in Kinnikinnic River Valley. A few other areas occur as bench land along stream courses in other townships.

The surface of this soil is level or nearly level, and natural drainage is good. The depth to the sand substratum is in most places sufficient to make the soil fairly drought resistant.

Waukesha silt loam is mostly derived from alluvial material deposited as stream terraces or as outwash plains during glacial times. The parent material is noncalcareous, and both surface soil and subsoil are acid.

This soil was prairie land, and the chief native vegetation was prairie grasses, the decay of which causes the dark color and high organic-matter content. Although it is of small total extent, Waukesha silt loam is one of the most desirable soils in the county. It is well adapted to all crops common to the region. Cabbage is a special crop which does well, and sugar beets thrive.

In the improvement of Waukesha silt loam lime should be used, especially for clover and alfalfa, and phosphatic fertilizers give good results.

WAUKESHA LOAM

The surface soil of Waukesha loam, to an average depth of 6 inches, consists of dark-brown or black medium loam containing some coarse grains of sand which in places give the material a coarse feel. Between depths of 6 and 18 inches, the material is brown, heavy-textured loam. Between depths of 18 inches and 3 feet, the soil grades to gravel or sandy material. Some variations occur in the texture of the surface soil and in the depth to gravel and sand.

Waukesha loam is of small extent, and most of it occurs in the townships of River Falls, Oak Grove, and Salem. Parts of the cities of River Falls and Prescott are on this soil. Areas are level or nearly level, and natural drainage is excessive in many places because of the coarseness and openness of the subsoil. In origin this soil is alluvial, having been deposited by running water as outwash plains or stream terraces. The parent material is noncalcareous, and both surface soil and subsoil are acid. This was originally prairie land, semi-prairie land, or "oak openings," and the chief vegetation was prairie grasses, the growth and decay of which account for the dark color and high organic-matter content of the soil.

Waukesha loam is a productive soil but is a little droughty at times. It is well adapted to all crops common to the region and to truck crops. The soil needs lime and will respond to phosphatic fertilizers.

LA CROSSE FINE SANDY LOAM, DARK-COLORED PHASE

In cultivated fields the surface soil of La Crosse fine sandy loam, dark-colored phase, to a depth of 6 inches, consists of dark-brown fine sandy loam which in places is very heavy. Locally, the surface soil

consists in part of medium and coarse sand and is sandy loam in texture. Between depths of 6 and 16 inches, the material is yellowish-brown heavy fine sandy loam or loam. Below a depth of 16 inches it is dark yellowish-brown gravelly loam which at a depth of 2 feet grades to nearly pure gravel. The soil is variable in texture and also in the depth to gravel.

This soil is of small extent and of minor agricultural importance. It occurs principally in Trenton, Diamond Bluff, and Salem Townships, but a few small scattered areas are in other parts of the county. Areas are level or nearly level, and natural drainage is good. On account of the gravelly substratum, the soil is somewhat droughty at times.

The material forming this soil is alluvial, having been deposited by streams during glacial times. Both surface soil and subsoil are acid in reaction. This soil was said to be practically treeless in the early days. The chief growth was prairie grasses, the decay of which accounts in part for the dark color of the soil. Most of this soil has been brought under cultivation. Because of its small area few, if any, farms consist entirely of it. This is a soil especially suited to truck crops and intensive farming, and where market facilities are favorable it should be devoted to this type of farming. It is also suited to most crops common to the region, but because of its gravelly and sandy substratum crops are apt to suffer from drought.

In improving this land lime should be used, and phosphatic fertilizers will probably give good returns.

SPARTA SAND

The surface soil of Sparta sand consists of dark grayish-brown sand containing considerable coarse sand and some gravel and continuing to a depth of 10 inches. Between depths of 10 and 26 inches is grayish-brown or light grayish-brown sand, and between depths of 26 and 36 inches is yellowish-brown sand. Through the whole soil the material is loose, open, and incoherent. Some variations, mostly in the color of the surface soil and the depth to which the dark color extends, are present. In some places the soil is loamy sand.

Sparta sand occurs most extensively on the high terraces along Mississippi River in the townships of Isabelle and Trenton. Smaller areas are along other streams within the county. Areas are nearly level, and because of the sandy texture of both surface soil and subsoil the natural drainage is excessive, and the soil is droughty. Practically all of the terraces where this soil occurs are more than 50 feet above the river, so that the water table is far below the surface.

Sparta sand is derived from alluvial material deposited in the form of stream terraces or outwash plains. The material is largely quartz sand, but small quantities of material from crystalline rocks are present. Both surface soil and subsoil are acid.

Sparta sand was originally partly prairie land and partly forested with scattered oak and probably some pine.

Sparta sand has a comparatively low agricultural value. The principal crops are corn, rye, oats, some hay, and a few special crops, but yields are low and returns small and discouraging. The soil requires lime, organic matter, and mineral plant foods.

GENESEE SILT LOAM

Typical Genesee silt loam is a light-colored first-bottom soil subject to annual overflow. It varies in texture from fine sandy loam to heavy silt loam. Most of it, however, is heavy. The surface soil is silt loam from 8 to 14 inches thick. It is underlain by silt loam which may be somewhat heavier, although in many places the silt loam extends to a depth of 3 or more feet. The surface soil is commonly more uniform in texture than is the subsoil. In numerous areas the subsoil, at a depth varying from 18 to 24 inches, is black or nearly black. The surface is in most places level or gently sloping toward the stream. Although the land is subject to overflow, there are numerous areas where flooding occurs only during the heaviest rains and where the water does not stand after rains.

Probably the largest area of Genesee silt loam in Pierce County is near the mouth of Rush River. This area is low, and the drainage is poorer than typical. Many other long narrow areas are scattered over the county along the small streams and intermittent drainage ways. This soil forms a small part of many farms.

The better-drained areas are more uniform in texture, and the soil is similar in many respects to Bertrand silt loam, into which it grades in many places so that no sharp line can be drawn between the two soils. It differs from Bertrand silt loam in that the latter, where typically developed, occurs as terraces or second bottoms whereas Genesee silt loam is a first-bottom soil. Bertrand silt loam is seldom flooded, but Genesee silt loam may be flooded each year. Another difference is that the Bertrand soil has a well-defined heavier subsoil horizon which is lacking in Genesee silt loam. Genesee silt loam is both alluvial and colluvial in origin, as mapped in this county.

The better-drained areas of Genesee silt loam are good agricultural land and are farmed in many places. Although they may be subject to overflow, the water does not stand on the ground long at a time, and crops can be grown on most of it every year. In some places, where the soil occurs along the border of the upland, the surface is flooded only at very rare intervals.

This is one of the most productive soils in the county. The chief crops grown are corn, small grain, and hay, all of which do well, although the small grain sometimes lodges. The better-drained areas are mostly in the broad bottoms where the valleys are from one-fourth to one-half mile wide. Numerous areas are along Rush River, as well as along many of the other streams of the county. Few farms are made up entirely of this soil, as most of it occurs in narrow strips along the stream courses.

The native vegetation on this soil was ash, elm, soft maple, willow, and some oak. Most of the timber has been removed, and considerable of the soil is in pasture.

The poorly drained areas of Genesee silt loam are used more for pasture than are the better-drained areas.

GENESEE SANDY LOAM

Genesee sandy loam includes the light-textured bottom lands of the Genesee series. These areas range in texture from sand to sandy loam. Because of the danger of flooding, the soil is used mostly for pasture and affords fair or good grazing. Mapped areas of this soil

include some small areas of river wash which is worthless for agricultural use.

Genesee sandy loam is of small extent. It occurs in Spring Lake Township along Eau Galle River and Cady Creek, in Union Township along Plum Creek, and in a few areas along Rush River and Kinnikinnic River. Some of these patches were too small to map and were included with mapped areas of Genesee silt loam. The soil, as a whole, is of little agricultural value at present.

ALLUVIAL SOILS, UNDIFFERENTIATED

In the soil survey of Pierce County the soils of the first bottoms along Mississippi River are grouped together as undifferentiated alluvial soils. Because of the extreme variations in color and texture and because the material changes from year to year, due to flooding, it was considered impractical to undertake the separations usually made in mapping soils. However, two general separations were recognized: A heavy-textured group, and a light-textured group of materials. The heavy material, as most typically developed, has a surface soil of brown smooth silt loam 8 inches thick, which is very uniform in texture. From a depth of 8 inches to more than 3 feet, the material consists of light-brown silt loam with thin layers of fine or very fine sand through it. In some places the entire subsoil is fine or very fine sand and in some places the silt loam predominates. The material in most places is mottled in the lower depths.

Some of this land is at the mouth of the Rush River, but the largest areas are in the Mississippi River bottoms between the head of Lake Pepin at Bay City and Diamond Bluff. In places this bottom land on the Wisconsin side is more than 1 mile wide.

This land is mostly forested with oak, elm, ash, soft maple, and other trees and shrubs which thrive under moist conditions. The growth includes considerable merchantable timber. Open places are covered by a dense growth of grass. In the spring and after heavy rains most of this land is covered with water. In dry seasons the grassland would supply good grazing, but at the time the survey was made very little of it was used as pasture, as water-filled sloughs and abandoned channels make it impossible to get livestock on the land. Under present conditions none of this soil is utilized for cultivated crops.

The light-textured soils of the Mississippi River bottoms are, for the most part, sandy, consisting of sand, fine sand, and sandy loam. In places some heavier material has been included. This is all alluvial land and is being added to or moved about by each flood. If it could be reclaimed, it would be inferior to the heavy-textured soil. Where timber is found, it is about the same as on the heavy-textured soil.

The largest areas of this light-textured soil are between Bay City and Diamond Bluff and along Lake St. Croix at the deltas of small inflowing streams. Such places are mostly barren sand flats and have no present agricultural value.

RIVER WASH

River wash is a term applied to the most recent stream deposits. Most of the material is sandy and gravelly and is being added to or modified somewhat by each flood. It is of no agricultural value and

is small in area. Some of it occurs in the townships of Trenton and Diamond Bluff. It occurs as small, barren stretches of sand or sand and gravel and has very little vegetation on it. It is all subject to overflow, and the only use being made of it is as road material.

ROUGH STONY LAND

Rough stony land comprises the steep, rocky slopes bordering the terraces and bottom lands along Mississippi River and most of the tributary streams. In places, it includes almost perpendicular rock cliffs rising to a height of several hundred feet, and in other places the steep rocky slopes are covered by a thin veneer of soil. Many rocky areas have no agricultural value. Where there is a covering of soil, the land supplies some grazing and supports a growth of trees. None of it should be used for cultivated crops and, in fact, very little of it could be so utilized. Areas in forest should remain forested, and the timber should be cut as it matures. Many of the farms of the county include some of this type of land. The rock outcrop is, for the most part, limestone, although there are also some outcrops of sandstone. The limestone is utilized in numerous places for road material, and much of it is of such quality that it can be ground and used for agricultural purposes.

SUGGESTIONS FOR THE IMPROVEMENT OF PIERCE COUNTY SOILS

SOIL EROSION

One of the important problems in soil management in Pierce County is that of checking erosion. This county is in the region of very old glaciation and in its surface features very much resembles the unglaciated country of southwestern Wisconsin. The roughest areas are immediately bordering the Mississippi River, where the valley floors lie from 200 to 500 feet below the ridges which extend between them. The valleys and their tributaries radiate like the veins of a leaf and the inclosing steep slopes make up a considerable part of the area of the county.

Most of the soil on the sloping land is heavy and is included in the steep phase of Clinton silt loam. These slopes, which originally were timbered or brush covered, have been largely cleared and cultivated. Because of their unprotected condition and exposure to the work of surface run-off from higher land, many fields on this type of soil are extensively washed and gullied by the storm water and the water from melting snow in spring.

Other soils subject to erosion are the soils of the Boone series, which in many places occupy lower slopes in the valleys. The soils of the Bertrand series, which occur on narrow benches along the sides of the valleys, are also subject to severe gullying. The swift-flowing water from the ridges and slopes must cross these benches before reaching the streams, and deep ravines and gullies are developed.

Soil erosion is a farm problem not only because fields are cut by gullies which make cultivation difficult but because erosion reduces the productivity of the fields by removing the loose, friable surface soil and with it nearly all the organic matter in the soil. The causes of removal of soil from the surface without formation of gullies generally lie in improper methods of cultivation or poor arrangement of

fields. Many fields where this kind of erosion occurs are only gently rolling or undulating. The rain water does not collect in larger, swift-flowing rills or streams which have power to cut gullies but follows the cultivated rows of such crops as corn or potatoes or the drill rows in grainfields.

Contour cultivation and arrangement of the crop rows across the slope instead of with or down the slope retard the downward movement of soil in such fields. Keeping the most exposed places in sod as much as possible and the cultivation of the field in alternate strips of crop and sod across the slopes are inconvenient but, in many fields, necessary methods.

Crop rotations in which two cultivated crops do not follow in succession give the field opportunity to recover from its losses under cultivation. Avoiding a hard, bare condition of the eroded ground after harvest prevents surface wash in the fall. A cover or catch crop of rye or peas in the corn rows helps protect the soil after harvest. Deep plowing and the plowing under of straw, manure, or a second crop of clover to increase the supply of organic matter in the soil give the surface of the field greater absorbing capacity and resistance to erosion.

Gullying occurs where great volumes of water collect, where steep slopes cause the water to flow swiftly, and where the soil has an unstable foundation of sandy material which easily undermines when the water once cuts through the surface soil. Large gullies one-half mile or more in length are sometimes cut during a single season.

In their beginnings most small gullies are easily controlled, as they can be filled with straw or manure and plowed shut. Small, shallow drainage ways should be left in permanent sod. On the level terraces or where heavy surface soils overlie light sand or sandy gravelly subsoils, small gullies must be immediately attended to. Where the subsoil is clay and clay or silt soil material is being brought down by the flood water, large gullies may be filled by putting in a dam of stumps, brush, and logs. Where the subsoil is sandy, much greater care is required, and if dams are built they need to be carefully constructed to prevent the water from cutting around them. Dams of concrete, stone, wire mesh, and brush have been successfully used. Flume devices also have been used to carry the water over the head of the ditch and down into it, preventing its continued growth.

Planting willows and brush on the sides and bottom of ditches too deep to fill often arrests the growth of the ditch. Sorghum, sweet clover, or rye make good emergency crops on eroded spots and fields which later need to be seeded to grasses and left in permanent sod.[1]

AGRICULTURAL METHODS

The tendency throughout Pierce County is toward better methods of cultivation, fertilization, and seed selection, and as a result yields are being increased and the more profitable types of agriculture developed. Fall and spring plowing are both practiced. One advantage of fall plowing is that it greatly reduces the farm work in the spring when every day is precious. Where land for spring-sown grains is plowed in the fall, the yield is commonly somewhat better than if the

[1] For a complete discussion of the question of erosion, see WHITSON, A. R., and DUNNEWALD, T. J. KEEP OUR HILLSIDES FROM WASHING. Agr. Wis. Expt. Sta. No. 272.

land is plowed in the spring. If plowed in the fall and disked in the spring, a very good seed bed can easily be prepared on the silt loam soils which predominate in the county. Land is commonly plowed from 4 to 7 inches deep. Where weeds and quack grass are plentiful, some farmers plow both in the spring and fall.

Considerable manure is hauled out during the winter and spread on land which was plowed in the fall. Most of the manure is applied to corn ground, most of which is plowed in the spring. Steep land should not be plowed in the fall on account of the tendency to wash. Neither should steep land be top-dressed with manure during the winter, because of the danger of losing the best part of the manure through washing.

Through the efforts of the county agent, the growing of alfalfa is being rapidly extended. Pierce County is now one of the leading counties in the State in the production of this crop. The average yield of alfalfa is given as 2.6 tons to the acre.

Soy beans are used to a greater extent each year with corn for silage, for an emergency hay crop, and for a seed crop. The Wisconsin Ito San, the chief variety planted, seems to be well suited to the soils of Pierce County.

ROTATION OF CROPS

In discussing crop rotations, farm crops may be divided into three classes: (1) Grain crops; (2) hay crops, such as legumes and timothy; and (3) cultivated crops, such as corn and potatoes.

A good rotation should include crops belonging to each of these three classes. The value of such practice is apparent in its effect on the physical condition of the soil, on weediness, on organic-matter supply, on plant diseases, and on nitrogen supply of the soil. Better yields are obtained when crops are rotated than when a single-cropping system is followed. Also, crop rotation permits the raising of livestock and means diversified farming.

One of the most common rotations followed in Pierce County consists of corn, small grain, and hay. This is sometimes a three-year rotation, though it may be lengthened to four, five, or even six years. Where the soil is very productive, corn is sometimes grown for two years in succession and is followed by a small grain. If the grain is apt to lodge, small grain may be grown on the same field for two years. The second year there will be less danger of lodging. The small grain is followed by hay, and if clover and timothy are both grown, as they are on many farms, this makes a six-year rotation. The hay crop is sometimes pastured the second year, but where there is plenty of steep land in permanent pasture this is not necessary, and hay is cut for two years before the land is plowed again for corn. Of the small grains, oats is grown most extensively. Wheat ranks second in acreage. Barley may be one of the small grains in the rotation and usually is on sandy soils.

A very good rotation, where dairying is an important factor in the farm practice, is clover, corn, and spring wheat. Clover is probably the most profitable crop of the rotation. Corn is second. Both of these crops supply excellent feed and are usually marketed to best advantage through the livestock. Alfalfa is an excellent crop to grow, but where a good stand can be obtained and maintained it is

probably best not to attempt to rotate it with other crops but to keep it as long as the stand is profitable.

Tobacco can well be grown on the same field for two or three years. It should be followed by corn for two years and small grain, seeded with clover, for one year. If a second crop of clover is plowed under some of the manure can be saved for other parts of the farm. Tobacco is grown successfully on Clinton silt loam and Carrington silt loam.

Where it is desired to grow peas for canning, this crop may be introduced into the rotation very readily. A four-year rotation may consist of small grain, clover, a cultivated crop, and then peas.

The growing of sugar beets is also an important industry, and beets may be introduced into the rotation without difficulty. Beets can be grown very successfully after tobacco.

Potato growing, when properly managed, is a profitable industry in many parts of the State. Although good crops may be grown on heavy soils, the sandy loams are especially well adapted to potato production. For best results potatoes are grown in rotation with other crops and should always follow a legume of some kind. In the rotations which have been given, potatoes can be planted as one of the cultivated crops. The three-year rotation given above is excellent for farms where potatoes are the principal crop, the potatoes taking the place of corn. As a rule, cropping to potatoes oftener than once in three years is not recommended.

In the sandy parts of Pierce County, somewhat different rotations should be followed. The following is probably the best for most sandy farms: Clover, seeded lightly with rye or oats, first year; clover for hay, leaving the second crop to be turned under either in the fall or spring, second year; corn or potatoes, third year; soy beans, which may be used for feed, for hay, and for green manure, fourth year.

LIMING AND FERTILIZATION

Liming of the soils of Pierce County is rapidly being recognized as an important and profitable farm practice. In the spring of 1924 1,500 tons of ground limestone were ordered by the farmers of Pierce County for application to soils within the county.

Most of the soils are considered to be in need of lime, but the need depends on the crops to be grown as well as on the character of the soil itself. Practically all of the dark-colored prairie soils are acid. As a rule, the sandy soils also are acid. The light-colored silt loams show varying degrees of acidity at the surface and in many places the upper part of the subsoil is also in an acid condition. Clinton silt loam is calcareous in the deep subsoil, as are some of the other soils which are shallow over the bedrock. Even where the soil is shallow over limestone, the surface soil in many places shows the need of lime.

The degree of acidity is variable, and each farmer may find a wide variation in the need for lime on his farm. It is essential that every farmer should have his various fields tested before making an expenditure for lime. The county agent can do this, or samples may be sent to the department of soils of the University of Wisconsin, where free tests will be made. Failure of clover and alfalfa are often an indication of the need of lime. About 3 tons of ground limestone to

the acre is the usual application on those soils on which alfalfa is to be grown and 2 tons where clover is seeded. The amount to be used, however, varies with the degree of acidity, the character of the soil, and the crop to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement; clover, garden beans, barley, hemp, turnips, and radishes have a medium requirement; and vetch, white clover, oats, rye, bluegrass, potatoes, sorghum, and other crops have a low requirement for lime. As a rule the heavy acid soils need more lime than sandy soils showing the same degree of acidity.

Ground limestone is doubtless the most economical form in which lime can be extensively utilized in Pierce County. Lime should be applied to plowed land and thoroughly worked in by harrowing previous to planting the crop which is to be benefited. Either fall, winter, or spring applications may be made.

After making a first application of 2 or 3 tons to the acre, it is not likely that another application will be needed for from four to six years. The need should again be determined by soil-acidity tests, as well as by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to obtain the best results.

Although increasing amounts of ground limestone are annually being shipped into the county, large amounts of limestone within the county could be utilized to advantage. This is especially true where the haul from the station is long or the roads are steep.

The use of commercial fertilizers is rapidly increasing in Pierce County, particularly in those parts of the county where grain farming predominated in the early days. In 1923, 16 per cent superphosphate (acid phosphate), used at the rate of 100 pounds to the acre on oats, on a farm near Prescott, increased the yield from 32 to 44 bushels to the acre. This fertilizer was broadcast just previous to seeding the crop. It was noted that the clover seeding here was greatly helped. Increases of as much as three-fourths of a ton of clover hay have been noted on fields which were fertilized with superphosphate (acid phosphate) at the time of seeding to small grain the previous year.

Legumes, such as clover, alfalfa, and soy beans, must be depended on to maintain the nitrogen supply of the soil. Clover and other legumes fed on the farm will increase the nitrogen content of the manure and thus the soil will be enriched both from the actual addition of nitrogen by the clover crop and from the manure resulting from the feeding of these legumes. The use of phosphorus and lime will increase the yield of clover and indirectly increase the supply of nitrogen. The fields where it has been difficult to haul barnyard manure and where the crops have been very poor sometimes repay the use of fertilizers containing some nitrogen and potash as well as phosphorus. Most farmers use manure as a top-dressing for clover or apply it just previous to preparing the land for corn.

The use of nitrogenous fertilizers, such as ammonium sulphate or nitrate of soda, for fruit trees is now a common practice. In Door County, cherry orchards are regularly fertilized with either the

straight nitrate of soda, with sulphate of ammonia, or with combinations of these nitrogenous fertilizers together with a small quantity of potash and phosphoric acid. Ammonium sulphate or nitrate of soda may be used at the rate of 5 to 7 pounds for each mature tree, applied in the early spring around the tree within the root-feeding radius. Bush fruit, head lettuce, and celery are frequently fertilized with these nitrogenous fertilizers, small quantities being used as a side dressing on head lettuce and celery in order to produce a more succulent, tender growth. For bush fruits, such as raspberries, blackberries, and currants, such combinations as 9–7–3 [2] fertilizer or a mixture of 75 pounds of a 4–8–6 grade with 25 pounds of ammonium sulphate, giving a resulting mixture of about a 9–6–4 grade, are used with very good returns on such crops.

SUMMARY

Pierce County is in the west-central part of Wisconsin and comprises an area of about 586 square miles or approximately 375,040 acres. Physiographically it may be regarded as an elevated plain which has been dissected by stream action, producing numerous steep-sided valleys between which are broad-topped, gently rolling ridges. The roughest part of the county borders Mississippi River. This district is distinctly dissected, whereas the northern and northeastern parts have a constructional topography produced by glaciation. The general elevation of the uplands of Pierce County is about 1,100 feet.

The county lies within the drainage basin of Mississippi River, and most of the drainage water finds its way directly into this stream.

White men visited this region as early as 1680, but the first permanent settlement was not made until about 1849 when Prescott was established. Pierce County was set off from St. Croix County in 1853.

The county is traversed by two railway systems, the Chicago, Burlington & Quincy and the Chicago & North Western. Highways lead into all parts of the county, and many miles of improved roads have been constructed. There is very little traffic on the river at present.

Ellsworth, the county seat of Pierce County, is 43.9 miles from St. Paul.

The mean annual rainfall at River Falls is 30.82 inches and at Red Wing is 29.70 inches. This is, as a rule, well distributed throughout the frost-free season.

Pierce County is a region of diversified farming. During the past 20 or 30 years there has been a change from a system in which grain farming predominated to one in which dairying and mixed farming both occupy prominent places. Dairying is gradually coming to have a more important place.

Practically all general farm crops common to Wisconsin are grown in Pierce County, and agriculture is highly developed. The acreage of alfalfa is rapidly being extended.

Most farms are well equipped and buildings are for the most part kept in good repair.

[2] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

The well-drained upland soils of Pierce County are mostly light colored, although there are areas of dark-colored soil in the northwestern part of the county.

The soil-forming material in Pierce County includes residual material from limestone, sandstone, and shale, glacial drift, loess, and alluvial material, much of which is of recent deposition. The soils of the county have been classed in 13 soil series and 19 soil types.

Two light-colored upland soils, Clinton silt loam and Lindley silt loam, together with their steep phases comprise 64 per cent of the total area of the county. Both are good agricultural soils. The only dark-colored, well-drained soil of importance in the county is Carrington silt loam, also an excellent farming soil.

Among the problems which farmers of Pierce County have to face in managing their soils is erosion, as there is much steep land subject to washing. Considerable areas are in need of lime. The use of commercial fertilizers is increasing and by their use larger and more profitable yields are being obtained.

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[PUBLIC RESOLUTION—No. 9]

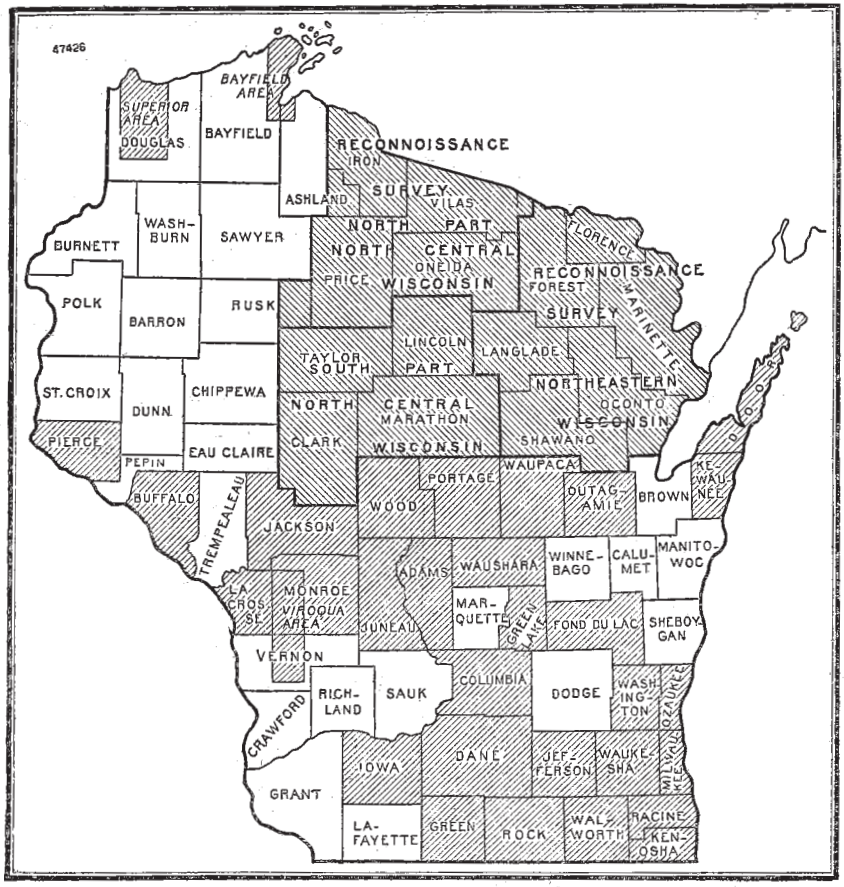
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Wisconsin, shown by shading

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CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
PIERCE COUNTY
WISCONSIN

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
ERNEST F. BEAN, DIRECTOR
UNIVERSITY OF WISCONSIN COLLEGE OF AGRICULTURE
H. L. RUSSELL, DEAN
A. R. WHITSON, IN CHARGE SOIL SURVEY

R. 20 W. | R. 19 W. | R. 18 W. | R. 17 W. | R. 16 W. | R. 15 W.

92° 45′ | 40′ | 35′ | 30′ | 25′ | 20′ | 15′ | 92° 10′

44° 50′ | T. 27 N. | 40′ | T. 26 N. | 40′ | T. 25 N. | 40′ | T. 24 N. | 44° 35′

ST. CROIX CO. | PIERCE CO. | BOUNDARY LINE | DAKOTA CO. | GOODHUE CO. | WABASHA CO. | PEPIN CO.

CLIFTON | RIVER FALLS | MARTELL | GLENMANN | SPRING LAKE | OAK GROVE | TRIMBELLE | ELLSWORTH | ELLSPASO | DIAMOND BLUFF | TRENTON | HARTLAND | ISABELLE | SALEM | MAIDEN ROCK | UNION | ROCK ELM

Prescott | Ellsworth | Martell | Spring Valley | Hatchville | Elmwood | Rock Elm | Diamond Bluff | Hager City | Maiden Rock | Plum City | Lund

MISSISSIPPI RIVER | LAKE PEPIN | Upper Lake | Lower Lake

LEGEND

Bertrand loam (Bm)	Dubuque silt loam (Ds)
Bertrand silt loam (Br)	Genesee sandy loam (Gs)
Boone fine sand (Bs)	Genesee silt loam (Gl)
Boone fine sandy loam (Bf)	LaCrosse fine sandy loam, Dark colored phase (L)
Boone silt loam (Bl)	Lindley fine sandy loam (Lf)
Carrington fine sandy loam (Cf)	Lindley silt loam (Ls)
Carrington silt loam (Cl)	(Ls) Steep phase
Clinton silt loam (Cs)	Sparta sand (Ss)
(Cs) Steep phase	Thurston gravelly loam (Tg)
Clyde silt loam (Cy)	Waukesha loam (Wl)
Conover silt loam (Cm)	Waukesha silt loam (Ws)
Riverwash (Rv)	Rough stony land (R)
Alluvial soils (*Undifferentiated*) (Al)	

CONVENTIONAL SIGNS

CULTURE (*Printed in black*)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R. Overcrossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines (State, County)
- Boundary lines (Land grant, City or Village)
- Boundary lines (Civil township, Reservation)
- U.S. township and section lines

RELIEF (*Printed in brown or black*)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low-water line, Sandbar

DRAINAGE (*Printed in blue*)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.